

REMARKS

In the last Office Action, the Examiner withdrew claims 9-30 from further consideration as being directed to a non-elected invention. Claims 1-4 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,670,717 to Kane et al. ("Kane"). Claim 5 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of U.S. Patent No. 5,229,607 to Matsui et al. ("Matsui"). Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of U.S. Patent No. 6,207,575 to Yang et al. ("Yang"). Claims 6-7 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,933,565 to Yamaguchi et al. ("Yamaguchi") in view of Yang.

In accordance with the present response, the specification has been revised to correct minor informalities. Independent claims 1-8 have been amended in formal respects to improve the wording and to bring them into better conformance with U.S. practice. Non-elected claims 9-30 have been canceled without prejudice or admission and subject to applicants' right to file a continuing application to pursue the subject matter of the non-elected claims. New claims 31-37 have been added to provide a fuller scope of coverage. A new abstract which more clearly reflects the invention to which the amended and new claims are directed has been substituted for the original abstract.

Applicants request reconsideration of their application in light of the foregoing amendments and the following discussion.

The present invention relates to a method of surface or cross-sectional processing and observation.

As described in the specification (pgs. 2-3), a conventional method related to the method of the present invention involves the formation of a cross-sectional structure exposed portion in a desired area in a sample surface and observation of the exposed surface or cross-sectional portion through a scanning ion microscope image using a focused ion beam or a scanning electron microscope (SEM) image using an electron beam. However, such conventional method has been associated with the problem of insufficient resolution for observation as a result of using the scanning ion beam microscope image or SEM image. The specific problem is that the resolution is insufficient to manage the very small thickness of the film structures being observed.

Another conventional method involves etching a desired area in a sample surface with a focused ion beam to take out a sample chip and observing the sample chip with a transmission electron microscope (TEM). However, this method has been determined to be time consuming and expensive to carry out.

Moreover, the foregoing conventional methods have only been capable of providing information on the geometry of a sample, not on electrical and mechanical characteristics of the sample.

The present invention overcomes the drawbacks of the conventional art. Fig. 1 shows an embodiment of a method of surface or cross-sectional processing and observation according to the present invention embodied in amended independent claim 1. According to the method of the present invention, in a first step at least one predetermined area 13 in a surface of a sample 12 is processed to form a target surface or cross-section. In a second step, the target surface or cross-section is observed by scanning the target surface or cross-section with a probe of a scanning probe microscope and detecting a physical quantity produced between the probe and the target surface or cross-section.

Amended independent claim 6 is directed to another embodiment of a method of surface or cross-sectional processing and observation. The method comprises a first step of processing at least one predetermined area in a surface of a sample to expose a target surface or cross-section, a second step of removing a damaged portion remaining in the exposed surface or cross-section and then forming a stepped portion according to a difference in materials among layers forming

the exposed surface or cross-section, and a third step of observing the exposed surface or cross-section with a scanning probe microscope.

By the foregoing methods, a sufficient spatial resolution for observing the target surface, exposed surface, or cross-section of the sample is achieved as compared to the conventional art. Furthermore, the methods according to the present invention facilitate the acquisition of electric, magnetic, and mechanical information for a target sample plane.

The prior art of record does not disclose or suggest the combination of steps recited in amended claims 1-8 and newly added claims 31-37.

Rejection Under 35 U.S.C. §102(b)

Claims 1-4 were rejected under 35 U.S.C. §102(b) as being anticipated by Kane. Applicants respectfully traverse this rejection and submit that amended claims 1-4 recite subject matter which is not identically disclosed or described in Kane.

Amended independent claim 1 is directed to a method of surface or cross-sectional processing and observation and requires a first step of processing at least one predetermined area in a surface of a sample to form a target surface or cross-section, and a second step of observing the target

surface or cross-section by scanning the target surface or cross-section with a probe of a scanning probe microscope and detecting a physical quantity produced between the probe and the target surface or cross-section. No corresponding combination of steps is disclosed or described by Kane.

Kane discloses a method for measuring electrical characteristics of an electrical device (Figs. 1-4). According to Kane (col. 8. lines 5-20), the surface of a hole 130 formed in a semiconductor composite 1 is coated with a metal film using CVD and performed by a focused ion beam (FIB) device. A metal pad 125 is then deposited over the hole 130 to provide a processed area in the form of a probe contact. The electrical device is then probed by having a probe touch the probe contact 125 to measure the electrical characteristics of the electrical device.

Thus in Kane, after FIB processing the processed area (i.e., the probe contact) is probed to measure the electrical characteristics of the electrical device, and no observation of the processed area takes place. In contrast, amended independent claim 1 recites a second step of observing the target surface or cross-section by scanning the target surface or cross-section with a probe of a scanning probe microscope and detecting a physical quantity produced between the probe and the target surface or cross-section. Stated

otherwise, Kane discloses the use of a probe to measure electrical characteristics, not to observe a target surface or cross-section as recited in claim 1.

It is noted that in column 4, lines 34-42, Kane discloses that electrical interconnections are verified by electrical probe measurements using a conventional tungsten wire probe as well as by AFM/SPM probe tip measurements. However, there is no disclosure in Kane of using any probe for the purpose of observing a target area.

In the absence of the foregoing disclosure recited in amended independent claim 1, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found"); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Kane for the reasons stated above. Furthermore, Kane does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Kane's method to arrive at the claimed invention.

Claims 2-4 depend on and contain all of the limitations of amended independent claim 1 and, therefore, distinguish from Kane at least in the same manner as claim 1.

In view of the foregoing, applicants respectfully request that the rejection of claims 1-4 under 35 U.S.C. §102(b) as being anticipated by Kane be withdrawn.

Rejections Under 35 U.S.C. §103(a)

Claim 5 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of Matsui. Applicants respectfully traverse this rejection and submit that the combined teachings of Kane and Matsui do not disclose or suggest the subject matter recited in amended claim 5.

Kane does not disclose or suggest the subject matter recited in amended independent claim 1 as set forth above for the rejection of claims 1-4 under 35 U.S.C. §102(b). Claim 5 depends on and contains all of the limitations of amended

independent claim 1 and, therefore, distinguishes from Kane at least in the same manner as claim 1.

The secondary reference to Matsui has been cited by the Examiner only for the feature of combining a FIB device with a microscope. Accordingly, Matsui does not cure the deficiencies of Kane as set forth above for independent claim 1, from which claim 5 depends, and one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

In view of the foregoing, applicants respectfully request that the rejection of claim 5 under 35 U.S.C. §103(a) as being unpatentable over Kane in view of Matsui be withdrawn.

Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Kane in view of Yang. Applicants respectfully traverse this rejection and submit that the combined teachings of Kane and Yang do not disclose or suggest the subject matter recited in amended claim 8.

Kane does not disclose or suggest the subject matter recited in amended independent claim 1 as set forth above for the rejection of claims 1-4 under 35 U.S.C. §102(b). Claim 8 depends on and contains all of the limitations of amended independent claim 1 and, therefore, distinguishes from Kane at least in the same manner as claim 1.

The secondary reference to Yang has been cited by the Examiner only for the feature of etching repeatedly until a desired portion profile is achieved. Accordingly, Yang does not cure the deficiencies of Kane as set forth above for independent claim 1, from which claim 8 depends, and one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

In view of the foregoing, applicants respectfully request that the rejection of claim 8 under 35 U.S.C. §103(a) as being unpatentable over Kane in view of Yang be withdrawn.

Claims 6-7 were rejected under 35 U.S.C. §103(a) as being unpatentable over Yamaguchi in view of Yang. Applicants respectfully traverse this rejection and submit that the combined teachings of Yamaguchi and Yang do not disclose or suggest the subject matter recited in claims 6-7.

Independent claim 6 is directed to a method of surface or cross-sectional processing and observation and requires a first step of processing at least one predetermined area in a surface of a sample to expose a target surface or cross-section, a second step of removing a damaged portion remaining in the exposed surface or cross-section and then forming a stepped portion according to a difference in materials among layers forming the exposed surface or cross-section, and a third step of observing the exposed surface or

cross-section with a scanning probe microscope. No corresponding combination of steps is disclosed or suggested by the combined teaching of Yamaguchi and Yang.

Yamaguchi discloses a method for correcting defects of an X-ray mask. A focused ion beam is used to irradiate at least a region having a defective portion of the X-ray mask. Contrary to the Examiner's contention, column 9, line 52 does not disclose or suggest the formation of a stepped portion as recited in the second step of claim 6.

While Fig. 9 of Yamaguchi illustrates the provision of a stepped portion, such stepped portion formed by irradiation of the focused ion beam during repair of the mask. In contrast, the second step of claim 6 recites removing a damaged portion remaining in the exposed surface or cross-section and then forming a stepped portion according to a difference in materials among layers forming the exposed surface or cross-section. Furthermore, as recognized by the Examiner, Yamaguchi does not disclose or suggest the third step of observing the exposed surface or cross-section with a scanning probe microscope, as recited in claim 6, and further such an observing step after the formation of the stepped portion as set forth above.

The secondary reference to Yang has been cited by the Examiner for its disclosure of a step for observing a surface using an atomic force microscope. However, since Yang does not disclose or suggest at least the second and third steps recited in claim 6, it does not cure the deficiencies of Yamaguchi. Accordingly, one ordinarily skilled in the art would not have been led to modify the references to attain the claimed subject matter.

Claim 7 depends on and contains all of the limitations of independent claim 6 and, therefore, distinguish from the cited references at least in the same manner as claim 6.

Moreover, there is a separate ground for patentability of dependent claim 7 which includes the additional limitation that the method further comprises the step of finishing the exposed surface or cross-section into a mirror face before the stepped portion is formed. No corresponding step is disclosed or suggested by the prior art of record. For example, in column 7, lines 47-51 Yamaguchi discloses that the ion beam is irradiated onto the defective portion and can be corrected and worked. However, Yamaguchi does not disclose or suggest finishing an exposed surface or cross-section into a mirror face before the formation of a stepped portion, as recited in claim 7

In view of the foregoing, applicants respectfully request that the rejection of claims 6-7 under 35 U.S.C. §103(a) as being unpatentable over Yamaguchi in view of Yang be withdrawn.

Applicants respectfully submit that new claims 31-37 also patentably distinguish from the prior art of record.

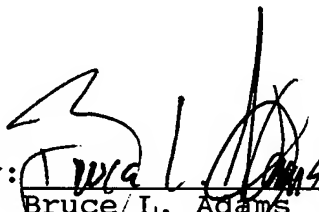
Claims 31-35, 36 and 37 depend on and contain all of the limitations of independent claims 1, 2 and 7, respectively, and, therefore, distinguish from the prior art of record at least in the same manner as claims 1, 2 and 7.

Moreover, there are separate grounds for patentability of several of the new dependent claims. For example, claim 37 includes the additional limitation that the step of finishing the exposed surface or cross-section into a mirror face is conducted by irradiating an electron beam in parallel with blowing of etching gas. No corresponding step is disclosed or suggested by the prior art of record.

In view of the foregoing amendments and discussion,
the application is believed to be in allowable form.
Accordingly, favorable reconsideration and allowance of the
claims are most respectfully requested.

Respectfully submitted,

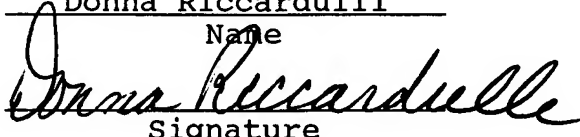
ADAMS & WILKS
Attorneys for Applicants

By: 
Bruce L. Adams
Reg. No. 25,386

17 Battery Place
Suite 1231
New York, NY 10004
(212) 809-3700

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Donna Riccardulli
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Date